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April 26, 1996

Ms. Karlene Fine, Executive Director
North Dakota Industrial Commission
600 East Boulevard Avenue
Bismarck, ND 58505

Dear Ms. Fine:

Enclosed please find a proposal entitled "Technical and Economic Feasibility Study for Utilization of North Dakota Lignite Bottom Ash". Tri-Star, Inc. has assembled an excellent team and looks forward to advancing coal combustion byproduct utilization in North Dakota through this project.

If you have any questions regarding this proposal, please feel free to contact me at (701) 282-0476 at your convenience.

Sincerely,



Mark Flaagan
President

Enclosure

c/enc: Andrew Stewart, Cooperative Power
Oscar Manz
Debra Pflughoeft-Hassett

**TECHNICAL AND ECONOMIC FEASIBILITY
STUDY FOR UTILIZATION OF NORTH DAKOTA
LIGNITE BOTTOM ASH**

Submitted to:

Karlene Fine, Executive Director

State of North Dakota
The Industrial Commission
Lignite Research Program
600 East Boulevard Avenue
Bismarck, ND 58505

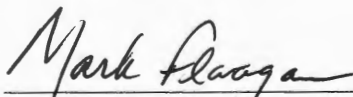
Submitted by:

Mark Flaagan

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*Funds Requested from the
Industrial Commission of North Dakota*

\$10,000



Mark Flaagan, President

April 1996

TABLE OF CONTENTS

ABSTRACT	ES-1
1.0 PROJECT SUMMARY	1
2.0 BACKGROUND	1
3.0 PROJECT DESCRIPTION	3
4.0 STANDARDS OF SUCCESS	5
5.0 QUALIFICATIONS	5
6.0 VALUE TO NORTH DAKOTA	6
7.0 MANAGEMENT	6
8.0 TIMETABLE	7
9.0 BUDGET	7
10.0 REFERENCES	8
RESUMES OF KEY PERSONNEL	Appendix A
BUDGET INFORMATION	Appendix B

TECHNICAL AND ECONOMIC FEASIBILITY STUDY FOR UTILIZATION OF NORTH DAKOTA LIGNITE BOTTOM ASH

ABSTRACT

In a recent report to the Industrial Commission of North Dakota, the Energy & Environmental Research Center (EERC) indicated that North Dakota lignite (NDL) bottom ash was characterized and found to have properties that make it a potentially valuable resource in roadbuilding and other applications (1). This potential has not been realized as shown by results of a regional ash utilization study (2). As reported by the EERC, the applications of high potential for ND Lignite bottom ash included road grit for skid control and aggregate replacement. The EERC also reported that the NDL bottom ash samples characterized in their study, all had low concentrations of regulated elements such as the RCRA (Resource Conservation and Recovery Act) elements. Since these materials are environmentally benign, their utilization is environmentally positive because it reduces the use of finite natural resources, reduces green house gas emissions produced from mining and manufacturing, and reduces the need for disposal. The premise in developing a market for NDL bottom ash in North Dakota is based on these environmental issues, and with development of additional technical and economic information, the feasibility of utilizing NDL bottom ash to replace natural materials will be determined.

The proposed approach, designed to make this determination, involves development and assessment of two primary sets of information. These are: 1) technical information regarding markets and appropriateness of NDL bottom ash; and 2) economic factors influencing marketability of NDL bottom ash. This information will be developed for a specific NDL bottom ash produced at Cooperative Power's Coal Creek Station near Underwood, North Dakota.

TECHNICAL AND ECONOMIC FEASIBILITY STUDY FOR UTILIZATION OF NORTH DAKOTA LIGNITE BOTTOM ASH

1.0 PROJECT SUMMARY

A research project is proposed to utilize information reported by the Energy & Environmental Research Center (EERC) on a project funded by the Industrial Commission of North Dakota. The EERC project developed preliminary technical information on a variety of North Dakota Lignite combustion byproducts including bottom ash (1). The goal of this project is to determine the technical and economic feasibility of utilizing North Dakota Lignite bottom ash in common applications statewide or regionally. The accomplishment of this project will provide the final information needed to begin taking full advantage of the NDL bottom ash resource in the marketplace. The proposed project will focus on a single NDL bottom ash produced at Cooperative Power's Coal Creek Station near Underwood, North Dakota, but the information collected and reported will have broad applicability statewide. Since it is anticipated that transportation will play a major role in the market for these materials, each NDL power plant has potential to develop a market share for their material based on location.

The approach for this project involves development and assessment of two primary sets of information. These are: 1) technical information regarding markets and appropriateness of NDL bottom ash; and 2) economic factors influencing marketability of NDL bottom ash. The project is anticipated to be accomplished in an eight month time period, and a comprehensive final report will detail the results.

2.0 BACKGROUND

Every year in North Dakota, 0.9 million tons of bottom ash are produced from energy production from North Dakota lignite (NDL) (2). A national survey published by the American

Coal Ash Association indicates that bottom ash is widely used nationwide in a variety of applications including road base and subbase, structural fills, snow and ice control, and in cement and concrete products (3). In a recent report to the Industrial Commission of North Dakota, the Energy & Environmental Research Center (EERC) indicated that North Dakota lignite bottom ash samples were characterized and were found to have properties that make these materials potentially valuable resources in roadbuilding and other applications (1). This potential has not been realized as shown by results of a regional ash utilization study. As reported by the EERC, the applications of high potential for NDL bottom ash included road grit for skid control and aggregate replacement. The ACAA survey results also indicated that bottom ash is already being utilized in these same applications nationally. The North Dakota State Department of Transportation and other county, township, and municipal agencies utilize natural resources for skid control and aggregate for a variety of needs.

Primarily because lignite and coal combustion byproducts are frequently disposed and disposed coal combustion byproducts (CCBs) are regulated as solid wastes, some concern has been raised about the potential for negative environmental impact from utilization of these materials, including bottom ash. However, there is overwhelming evidence that these materials are environmentally benign and that their utilization is environmentally positive because it reduces the use of finite natural resources, reduces green house gas emissions produced from mining and manufacturing, and reduces the need for disposal. In addition, the EERC reported that the NDL bottom ash samples characterized in their study, all had low concentrations of regulated elements such as the RCRA (Resource Conservation and Recovery Act) elements (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver). Further evidence of the environmentally benign nature of NDL bottom ashes was indicated by the results of the North

Dakota State Health Department's prescribed leaching tests. As shown in Table 1, the leachates from an 18 hour leaching test with distilled water contained extremely low concentrations of all elements. All of these issues make the utilization of NDL bottom ash an environmentally sound alternative to disposal. It is important to note that utilization can also be an important economic benefit to the utilities producing the bottom ash by reducing costs for disposal and will benefit the Lignite industry in North Dakota

TABLE 1

Results of Short-Term Leaching on North Dakota Lignite Bottom Ash

Parameter	Units	Antelope Valley Bottom Ash	Leland Olds Bottom Ash	Coal Creek Bottom Ash	M.R. Young Slag	Coyote Slag
Al	mg/L	9.59	13.0	2.10	2.16	3.68
As	mg/L	0.0051	0.0073	0.0084	0.014	0.0099
B	mg/L	1.66	1.65	2.73	0.31	1.18
Ba	mg/L	0.60	0.60	0.33	0.23	0.58
Cd	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cr	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Cu	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Mn	mg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Hg	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Ni	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ag	mg/L	< 0.0008	< 0.0008	< 0.0008	< 0.0008	< 0.0008
Pb	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Se	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Sr	mg/L	4.10	3.29	2.13	0.59	1.90
Ti	mg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
V	mg/L	< 0.05	0.065	0.064	< 0.05	< 0.05
Zn	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
pH		10.70	11.03	11.19	10.04	10.83
Conductivity	mmhos	0.66	0.54	0.69	0.10	0.38

(After Pflughoeft-Hassett, et al (1))

A key issue that has not been well addressed, and is required in order for North Dakota to realize the utilization potential of NDL combustion ash, is comprehensive technical and economic feasibility of utilization of these materials. A study to determine this is proposed here. The proposed study will be specific to the NDL bottom ash from Cooperative Power's Coal Creek Station near Underwood, North Dakota, however the information developed is expected to be applicable to other sources of NDL bottom ash as well.

3.0 PROJECT DESCRIPTION

3.1 Introduction

The proposed project is designed to utilize information from a previous project funded by the Industrial Commission of North Dakota and advance NDL combustion byproduct utilization to a level beyond laboratory concept and field demonstration. A single NDL bottom ash produced at Coal Creek Station will be evaluated for technical appropriateness in selected applications. The market for this material will be evaluated, and the economics of getting this material into the identified markets will be determined.

3.2 Goals and Objectives

The goal of the proposed work is to determine the technical and economic feasibility of utilizing North Dakota Lignite bottom ash in common applications statewide or regionally. The supporting objectives of this program are: 1) to evaluate the properties of specific NDL bottom ash samples for utilization; 2) to identify applications and markets where bottom ash can replace other more costly materials or limited natural resources; and 3) to determine the economics of marketing NDL bottom ash for the selected applications, including potential processing, transportation, and market competition and prices.

3.3 Methodology

In order to achieve the goals and objectives for this project, the following tasks will be performed:

Task 1 – Evaluation of Markets and Appropriateness of Coal Creek Station Bottom Ash

The potential North Dakota bottom ash markets will be determined by an evaluation of information from several key sources. National and regional information on bottom ash utilization and markets from published literature and surveys will be used to develop broad categories of utilization applications and markets. After identifying these broad categories, more localized information will be collected and evaluated with a twofold purpose: 1) identifying applications where bottom ash can replace a currently used material and 2) identifying potential new markets. It is anticipated that North Dakota public records for state and local highway offices will provide valuable information on several applications. Further information will be collected through personal contacts with expected users or material suppliers. Key utilization applications and markets will be determined through careful evaluation of the compiled information.

Coal Creek Station bottom ash has properties that lead to the expectation of good performance in some anticipated utilization applications, but it is proposed to perform some limited additional technical evaluation of the material to demonstrate product quality. Additionally, the bottom ash will be evaluated for performance criteria specific to the most likely utilization applications. It is anticipated that this product quality and performance testing may include size distribution, hardness, and density. Some identified applications may require some processing of the bottom ash, such as grading by size, to meet aggregate specifications. If specifications or other performance criteria require processing of the bulk bottom ash, a laboratory demonstration of this process will be performed with appropriate testing of the processed bottom

ash. These factors will be considered in the economic evaluation in Task 2. All testing and laboratory demonstrations will be performed by an experienced engineering testing laboratory.

Task 2 – Evaluation of Economic Factors Influencing Marketability of Coal Creek Station

Bottom Ash

Numerous factors are important to development of an economic evaluation. The factors that will be considered for this project will include: value of the material in the identified applications and markets, size and location of markets, cost of the material to the marketer, cost of quality assurance testing and potential processing, and transportation costs. Each of these variables will be assessed on the basis of information collected in Task 1, and cost estimates will be made using Tri-Star's expertise in marketing and transportation. The result of Task 2 will be specific recommendations for applications and markets for Coal Creek Station bottom ash. It is anticipated that one or more applications and associated markets will be economically feasible in North Dakota and/or the region.

Task 3 – Reporting

A progress report will be submitted to the NDIC project manager 30 days following month three of the project. A comprehensive draft final report will be submitted for review at the end of month seven, and the final report will be submitted at the end of the project (end of project month eight). These reports are noted on the timetable indicated in Section 8.0 of this proposal.

4.0 STANDARDS OF SUCCESS

The standards of success for this project include: 1) a comprehensive evaluation of potential markets for NDL bottom ash; 2) a determination of the technical feasibility of utilizing Coal Creek Station bottom ash in identified applications; and 3) a comprehensive evaluation of the economic

feasibility of utilizing and introducing Coal Creek Station bottom ash into identified markets. These standards will be addressed in the comprehensive final report for this project.

5.0 QUALIFICATIONS

Mr. Mark Flaagan will act as Project Manager and Principal Investigator for this proposed project. Mr. Flaagan has experience in materials marketing and transportation through his association with Tri-Star, Inc. and has experience in developing marketing plans and strategies for that company. He is also familiar with the construction industry in North Dakota.

Ms. Debra Pflughoeft-Hassett will consult on this project to evaluate results and facilitate compilation and reporting. Ms. Pflughoeft-Hassett has experience working with the North Dakota and regional CCB industry and in data collection, evaluation, and reporting.

Mr. Oscar Manz, Professor Emeritus, Civil Engineering, University of North Dakota, and Manz Associates, will be consulting on this project in the areas of technical feasibility of bottom ash utilization and identification of applications. Mr. Manz has performed research on CCB utilization for over 25 years both while at the University of North Dakota and in his consulting business. He has extensive knowledge of engineering and construction applications for CCBs, properties of NDL combustion byproducts, and the construction industry in North Dakota.

Resumes for key participants in this project are included in Appendix A.

6.0 VALUE TO NORTH DAKOTA

The primary benefit to North Dakota and the Lignite producers is the economic benefit that can be realized by utilities when the disposal of a high volume byproduct, such as bottom ash, can be minimized. This disposal cost avoidance which is anticipated to result from developing markets for NDL bottom ash can be significant. Additionally, North Dakota benefits when lower

cost replacements can be found for commonly used materials and when the state's finite natural resources are conserved. Each of these benefits is an anticipated result of this study.

7.0 MANAGEMENT

The proposed project will be managed and coordinated by Mr. Mark Flaagan, Tri-Star, Inc. Mr. Flaagan is involved in materials marketing and transportation business of Tri-Star, Inc. and has experience in developing marketing plans and strategies for that company. Mr. Flaagan's resume is included in Appendix A.

8.0 TIMETABLE

The timetable for the proposed project is as follows:

Task	Initiation (Project Month)	Completion (Project Month)
Task 1		
-Market Evaluation	1	3
-Technical Evaluation of CCS Bottom Ash	1	4
Task 2		
-Economic Evaluation	2	6
Task 3		
-Progress Report	3	4
-Draft Final Report	6	7
-Final Report	7	8

The anticipated initiation date for this project is July 1, 1996. The evaluation phase of the project is expected to be completed within six months, and the final report will be submitted at the end of project month eight, which will be March 1, 1997, assuming the July 1, 1996, start date.

9.0 BUDGET

A budget detailing the costs for the proposed research is included in Appendix B. The total project cost is estimated to be \$20,000. Cooperative Power has agreed to provide \$10,000 funding as stated in a letter included in Appendix B. The funds being requested from the Industrial Commission of North Dakota are \$10,000. Letters from project consultants indicating their fees are also included in Appendix B. An affidavit stating that Tri-Star, Inc. does not have an outstanding tax liability owed to the state of North Dakota or any of its political subdivisions is also included in Appendix B.

10.0 REFERENCES

1. Pflughoeft-Hassett, D.F.; Dockter, B.A.; Eylands, K.E.; and Hassett, D.J.; "Survey and Demonstration of Utilization Potential of North Dakota Lignite Ash Resources," EERC report 96-EERC-04-01 to the Industrial Commission of North Dakota, April 1996.
2. Bryggman, T.; Nallick, J. "Use of Coal Combustion By-Products Status and Opportunities in Region 8," Associated Western Universities Fellowship, U.S. Department of Energy, Region 8: Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming, 1993.
3. American Coal Ash Association, Inc. 1993. "1993: Coal Combustion Byproduct-Production and Consumption," Washington, DC.